Improving the Way to Detect Cracks in Teeth

INTRODUCTION
Detecting cracks in teeth is one of the more challenging clinical situations. The "cracked tooth syndrome" was described more than 40 years ago, and clinicians still struggle to detect cracks early and to provide appropriate therapy. Patients usually present with vague symptoms, such as acute pain upon mastication of grainy and tough foods, and sharp brief pain with cold stimulus. These findings relate to cusp frac-

Figure 1. The Canary System.

ture, but there can also be other symptoms associated with a crack/fracture, such as slight to severe pain consistent with irreversible pulpitis, or pulpal necrosis. Periapical and bite-wing radiographs usually cannot image the crack or fracture. So the dilemma is how one detects, and then manages cracks/fractures in teeth.

This article will present a case report involving the use of the latest technology for the detection of a crack in a mandibular first molar.

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Predisposing Factors to Cracked Teeth
A number of papers indicate that cracked teeth were associated with intracoronal restorations and frequently found in mandibular molars. The most commonly identified etiologic factor was the design of the cavity preparations. Large restorations, inappropriate use of pins, restorations encroaching upon the marginal ridges or undermining the marginal ridges are some of the factors. Selection of
New Technology Introduced

New diagnostic tools are coming to market that can help to image and detect defects in the crystal structure of the tooth which are associated with cracks and fractures. One of these technologies, The Canary System (Figure 1), uses the energy conversion technology, called photothermal radiometry-luminescence (PTR-LUM), to image and examine the tooth. Pulses of laser light are shone on the tooth and the laser light is converted to heat (PTR) and light (LUM), which are emitted from the tooth surface when the laser is off. These harmless pulses of laser light allow a clinician to examine subsurface caries up to 5 mm below the surface.\(^{12,13}\) Carious lesions modify the thermal properties (PTR) and glow (LUM) from the healthy teeth. As a lesion grows, there is a corresponding change in the signal as the heat is confined to the region with crystalline disintegration (dental caries) and PTR increases and LUM decreases. As remineralization progresses and enamel prisms begin to reform their structure, the thermal and luminescence properties begin to revert back in the direction of healthy teeth.\(^{14-16}\) The system is so sensitive it detects very small changes in temperature (less than 1°C to 2°C); much less than that generated by a conventional dental curing light. These changes in temperature are imperceptible to the patient.

The Canary Number (ranging from zero to 100) is created from an algorithm combining the PTR and LUM readings and is directly linked to the status of the enamel or root surface crystal structure.\(^{17}\) A Canary Number of less than 20 indicates a healthy tooth surface. A Canary Number greater than 70 indicates a large lesion that may justify restoration. Canary Numbers falling between 20 and 70 indicate the presence of an early carious lesion or crack that doesn’t require a restoration but can be remineralized.\(^{18}\) The treatment decisions are based upon the type of remineralization treatment, the position of the lesion, and overall risk of developing caries including oral hygiene.

Research has demonstrated that PTR-LUM technology used in The Canary System can detect:

- Occlusal pit-and-fissure caries\(^{19,20}\)
- Smooth-surface caries\(^{21,22}\)
- Acid erosion lesions\(^{12,23}\)
- Root caries\(^{24,25}\)
- Interproximal carious lesions\(^{13,26}\)
- Beneath fissure sealants\(^{27}\)
- Beneath the intact margins of composite resins\(^{28}\)
- Demineralization and remineralization of early carious lesions\(^{24,29,31}\)

Photothermal radiometry-luminescence technology allows clinicians to detect small early lesions in order of 50 μm in depth up to 5 mm below the tooth surface, even in the interproximal regions of the teeth.\(^{32}\) It provides a repeatable measurement that is linked to the status of the enamel or root surface under examination.
A 53-year-old male presented complaining of tooth-borne pain upon cold stimulus during the previous 4 days. Upon examination, we could not localize the pain, and there was no pain on percussion. A bite-wing radiograph (Figure 2), taken at a recare visit 6 weeks previously, showed shallow occlusal amalgam restorations on the mandibular first and second molars. A periapical radiograph (Figure 3), taken at the time of the appointment, showed a large extensive amalgam restoration on the mandibular third molar, with a possible radiolucency associated with the mesial root. There was pain upon cold stimulus on all the mandibular right molars; however, it was most severe on the third molar. A recommendation was made to have this tooth extracted or endodontically treated.

The patient returned 3 days later and reported that the pain was now more localized to the mandibular first molar. Upon examination, the pain was more pronounced over the first molar. Photographs (Figure 4) were taken of the tooth and a Canary Scan done of both the occlusal and buccal surfaces.

The Canary Scan (Figure 5) showed Canary numbers of 58 associated with the mesial marginal ridge; 36 with the distal marginal ridge; and 97 with the lingual border of the occlusal amalgam. Upon removal of the amalgam (Figure 6), cracks were seen in both mesial and distal marginal ridges. There was also a substantial amount of recurrent caries around the lingual border of the amalgam.

The caries was removed from the lingual aspect. The cracks and caries along the mesial and distal marginal ridges were removed. A bonded mesial occlusal distal composite was placed.

A Canary Scan was done on the buccal amalgam on this tooth (Figure 7), indicating the presence of caries around the restoration. Upon removal of the amalgam, caries was indeed found and a new composite restoration was placed.

**IN SUMMARY**

Detection of cracks in teeth is a very challenging task. At times, the symptoms may not be indicative of the presence of a crack. In addition, bite-wing and periapical radiographs may not be able to image small microfractures. As a result, the clinician can be greatly assisted with technology that can directly examine the crystal structure of the tooth to detect any voids or porosities. The Canary System, using its PTR-LUM technology, provides the clinician with a diagnostic device to detect caries and cracks around the margins of restorations.

**References**


Dr. Abrams is a general dental practitioner with more than 30 years of clinical experience. Upon graduation from the University of Toronto Faculty of Dentistry in 1980, he established a group practice in Toronto, Canada, that has grown to involve general dentists and dental specialists. Dr. Abrams is the founder of Four Cell Consulting, Toronto Ontario, Canada, which provides consulting services to dental companies in the area of new product development and promotions. Dr. Abrams founded Quantum Dental Technologies, a company developing laser-based technology for the early detection and ongoing monitoring of dental caries. He is a Fellow of the Pierre Fauchard Academy and the Academy of Dentistry International, American College of Dentistry, a member of the Canadian Academy of Esthetic Dentistry, International Academy of Dento-Facial Esthetics, European Association for Caries Research, and International Association of Dental Research. He has published more than 90 articles in various international publications on topics ranging from early caries detection, prevention, removable prosthetics and restorative dentistry. He has developed the "Triple Lamine Technique" for utilizing soft tissue condensers. In 2002, Dr. Abrams was awarded the Barabas Day Award from the Ontario Dental Association for 20 years of distinguished service to the dental profession. He is one of the founding board members of ACCERTA Claim Corporations, a dental and pharmacy claims management company. He can be reached at (416) 265-1400 or at drabrams@cellsymptomatica.ca.

Disclosure: Dr. Abrams is the CEO and co-founder of Quantum Dental Technologies, the maker of the product mentioned in this article.
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